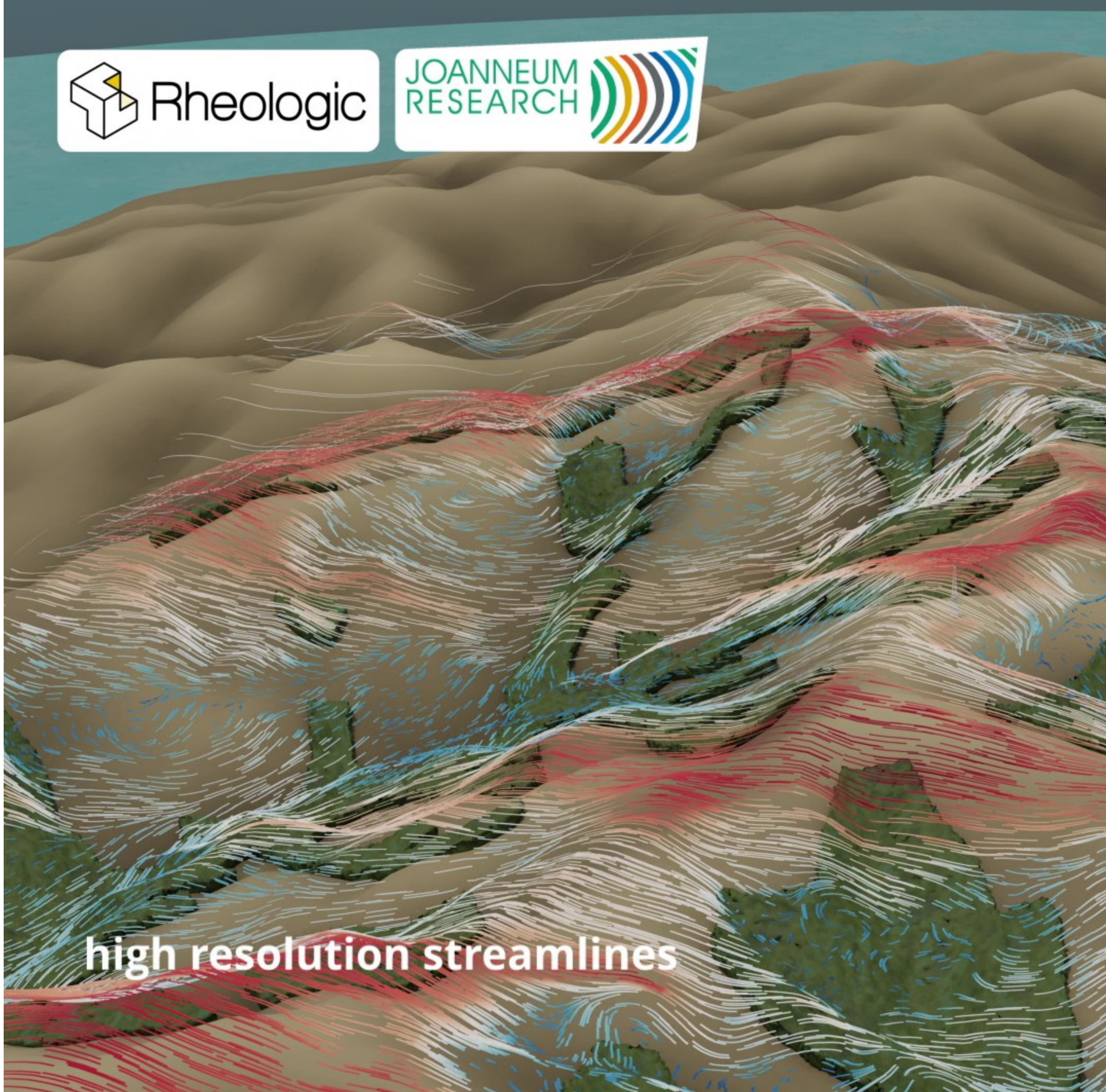
FFG ASAP Space4Wind user dissemination workshop

May 16 2025

Rheologic
Joanneum Research



Who we are

Rheologic

- Andras
- Christian
- Markus
- Sahir

Joanneum Research
DIGITAL – Institute Digital Technologies
Remote Sensing and Geoinformation

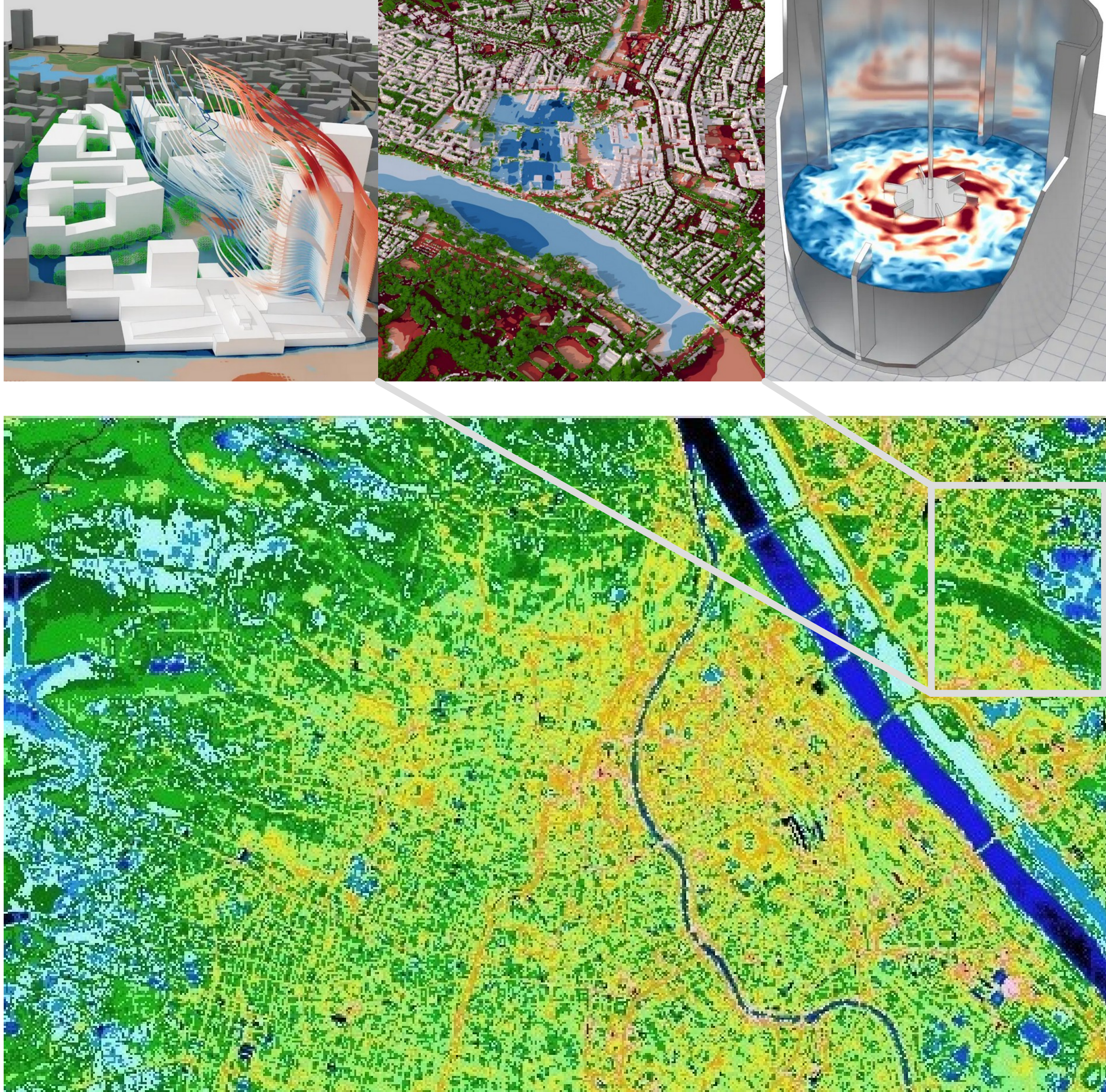
- Heinz
- Katharina

Green Energy Lab

What we are good at

Rheologic
- Wind power, comfort, danger
- (Urban)Microclimate
- Process intensification
- Clean rooms

Joanneum Research
- Processing of remote sensing data
- Validation of remote sensing services
- Copernicus services
- Environmental monitoring



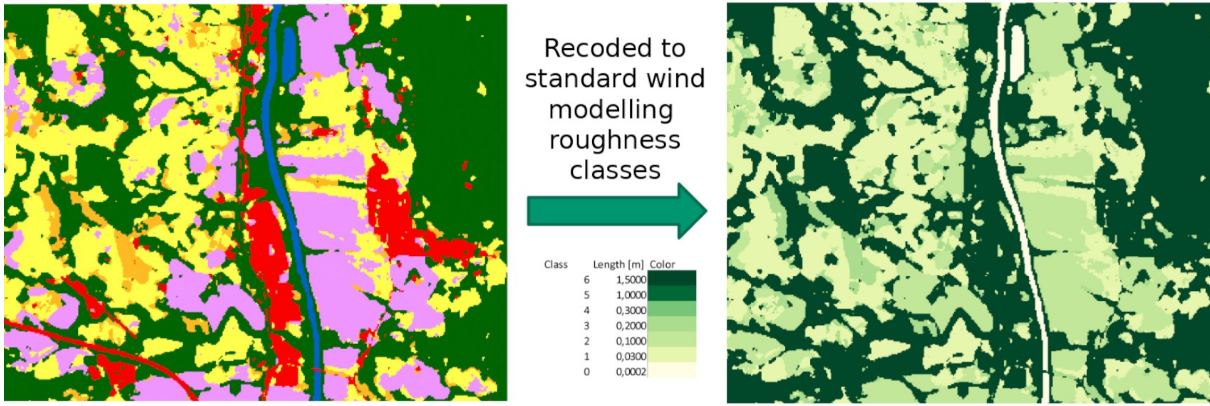
S4W ideation, goals, status

ESA/BIC Hackathon 2022
„Space applications“

Detailed surface features
Process automation

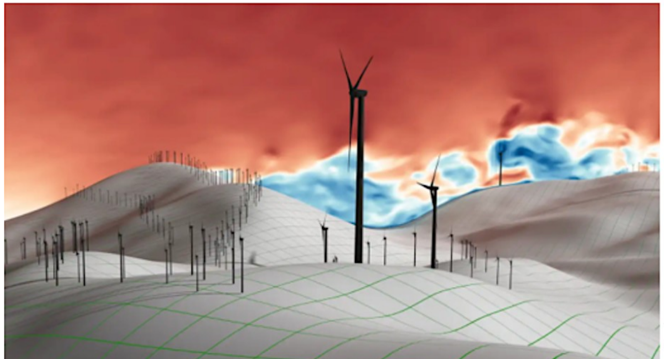
EO/WRF/CFD data pipeline
with global cover of input data

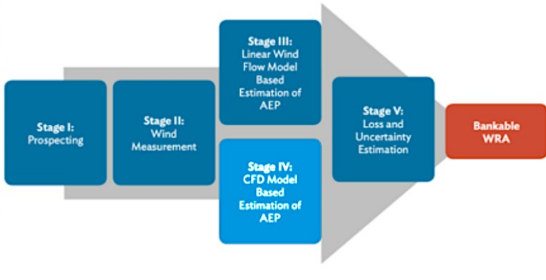
Global wind atlas | Test site: Rignano (11.450488°, 43.702897°) | SURF-EO Solution



ESA World Cover 2021 – For test site Rignano, Italy (11.450488°, 43.702897°)

Surface Roughness [10 m Resolution]





AEP = annual energy production, CFD = computational fluid dynamics, WRA = wind resource assessment

Source: Jain (2010).

Problem description

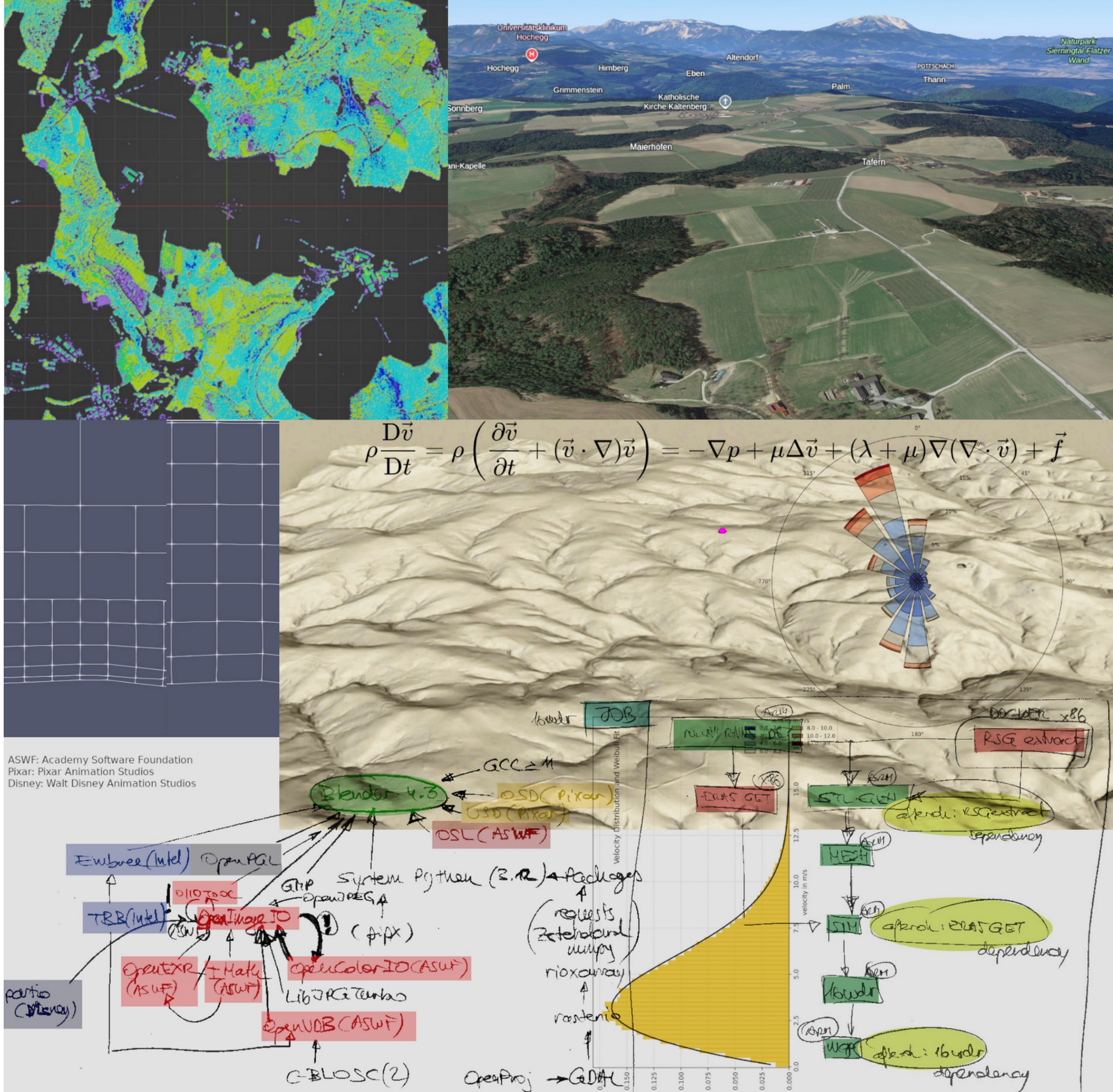
Have: complexity

Data acquisition
- Surface data
- Vegetation data
- Wind data

CFD Models
- Validation

Software
- Automation
- Reliability

HPC hardware/clusters



Problem description

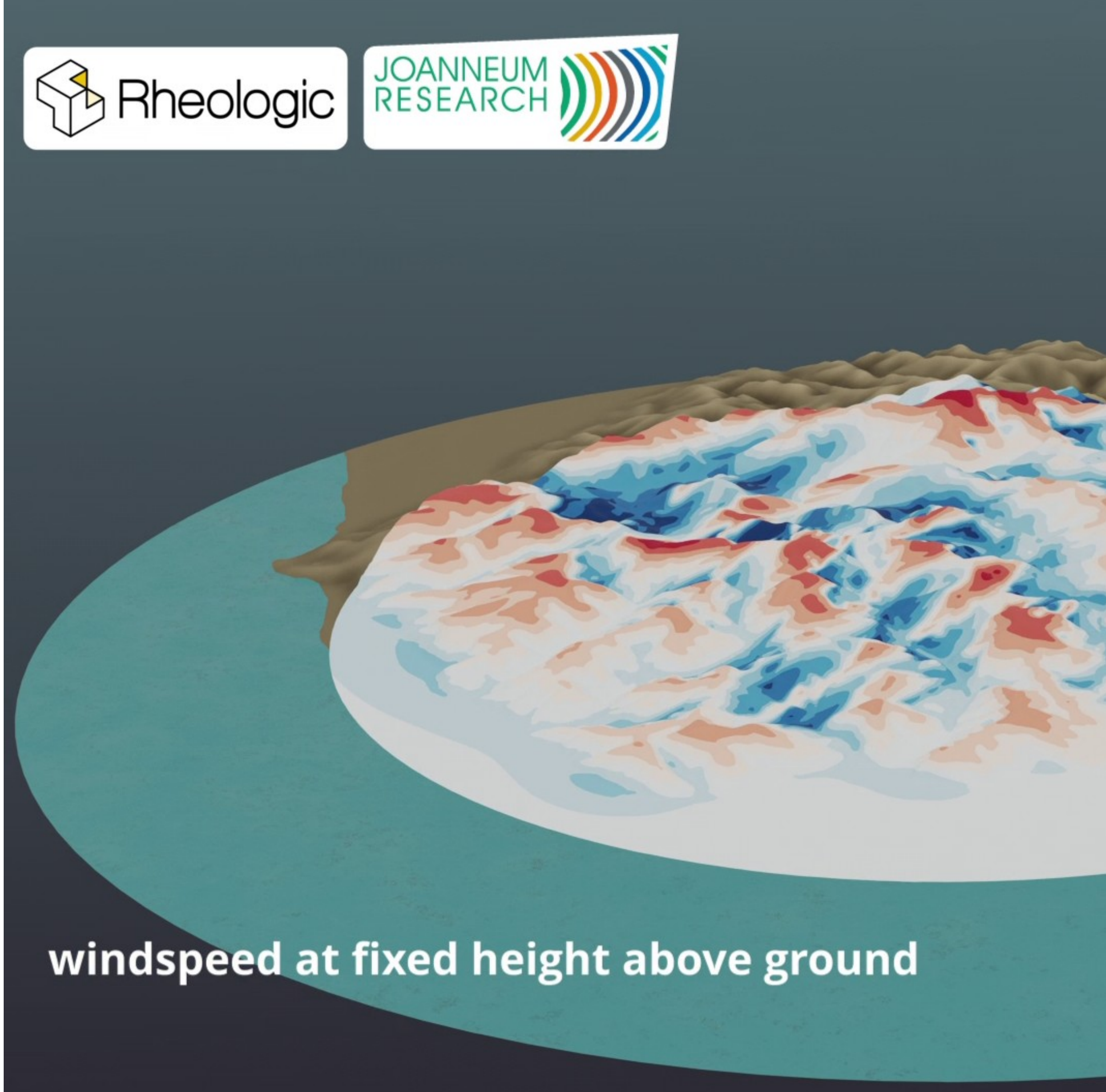
Want: simplicity

What is the expected Annual Energy Production (AEP)?

Optimal Wind Energy Converter (WEC) type?

What is the uncertainty of the yield prediction?

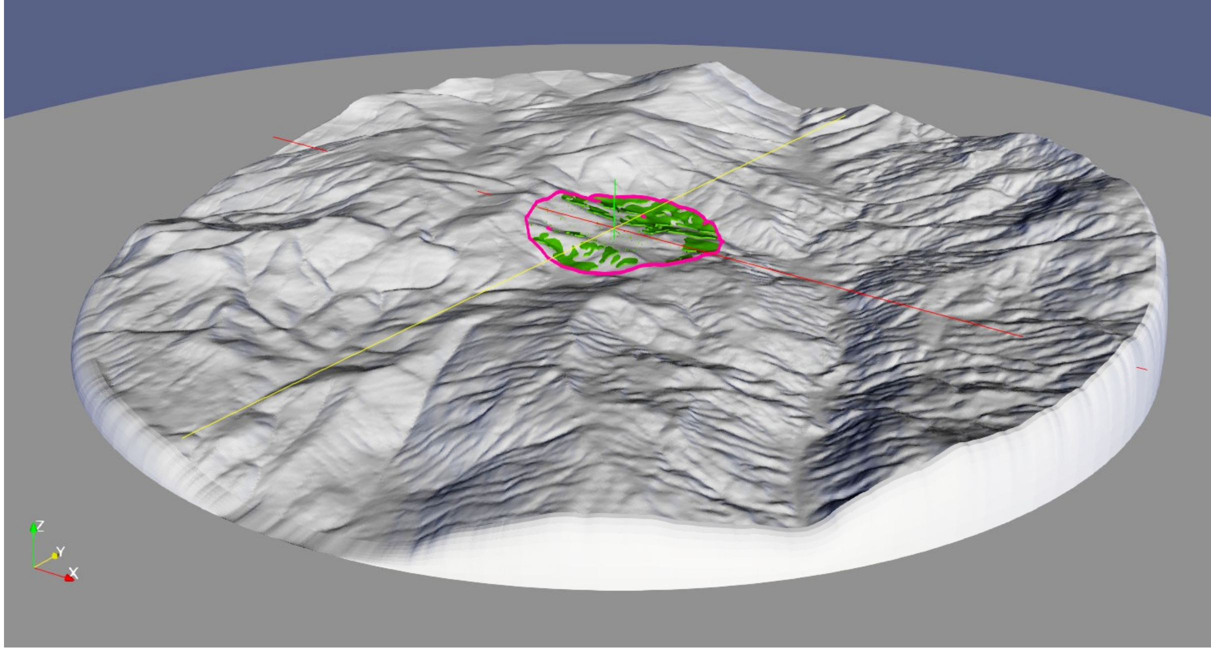
Where are the best spots to place the WECs?



Data flow

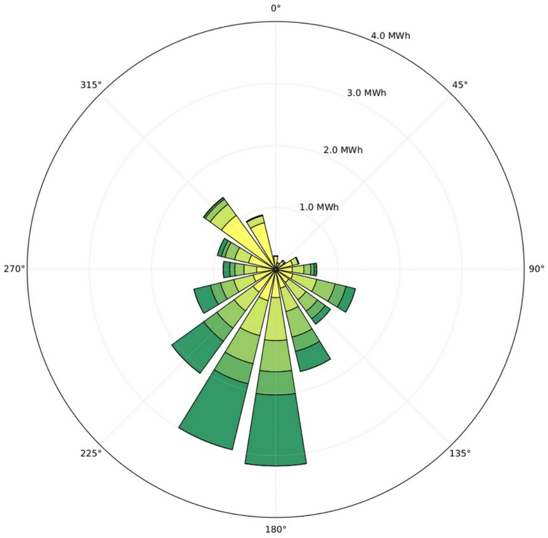
EO data and geometry

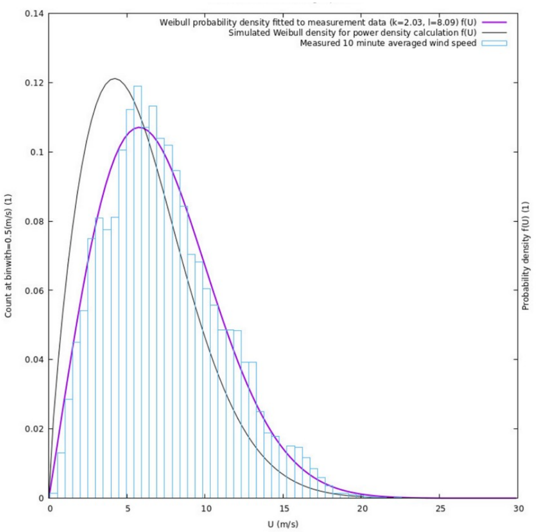
- Surface roughness classes
- Surface: COPDEM30
- RSG -> GeoTIFF
- reprojection, rescaling, cutting, void filling
- Forest canopy: META/WRI
- 10km turntable generation



Wind data

- ERA5, hourly, 10 year avg
- 16 sectors





Simulation

- Large Eddy Simulation

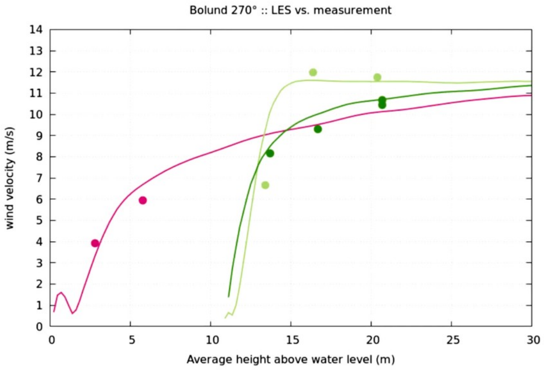
Accuracy of results

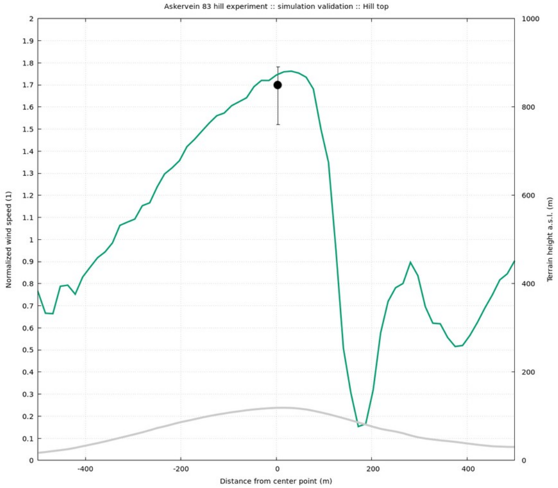
Terrain Ruggedness Index (TRI) classification

„Typical“ wind energy benchmarks

„Complex“ terrain

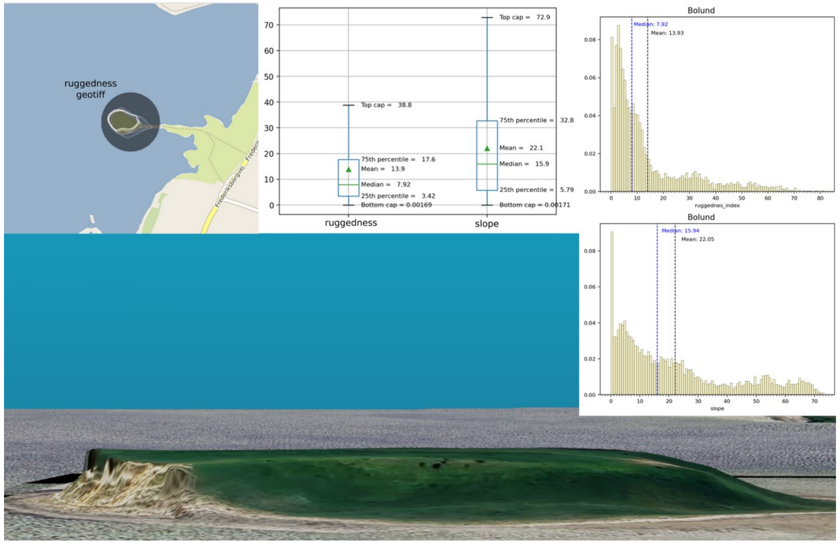
Validation





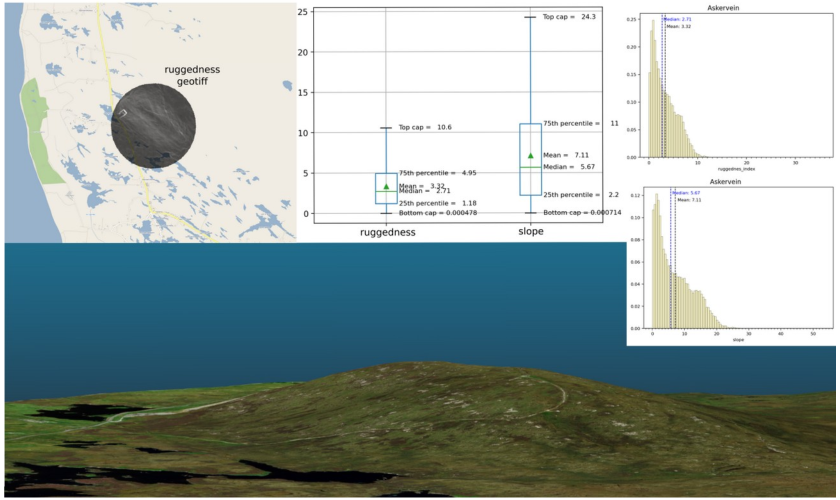
Bolund Denmark 12m

TRI 13.9



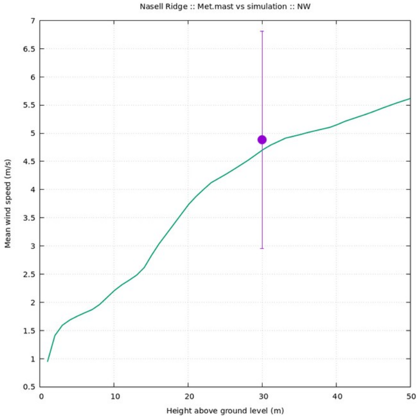
Askervein Scotland 116m

TRI 3.3

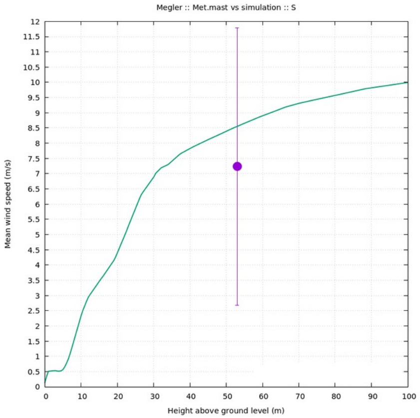


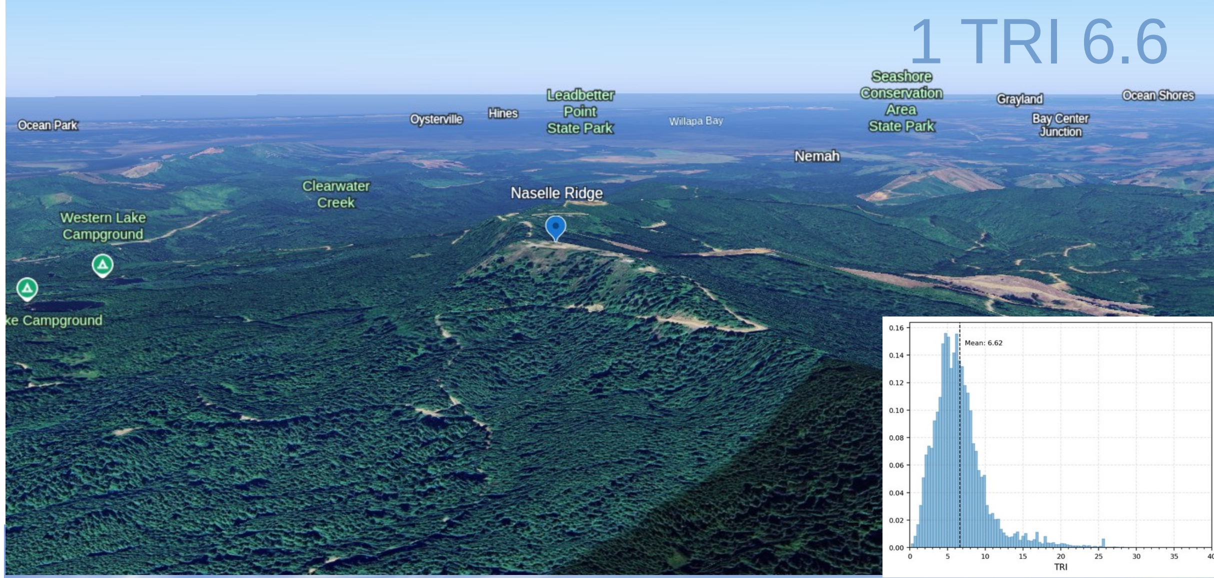
Validation sites

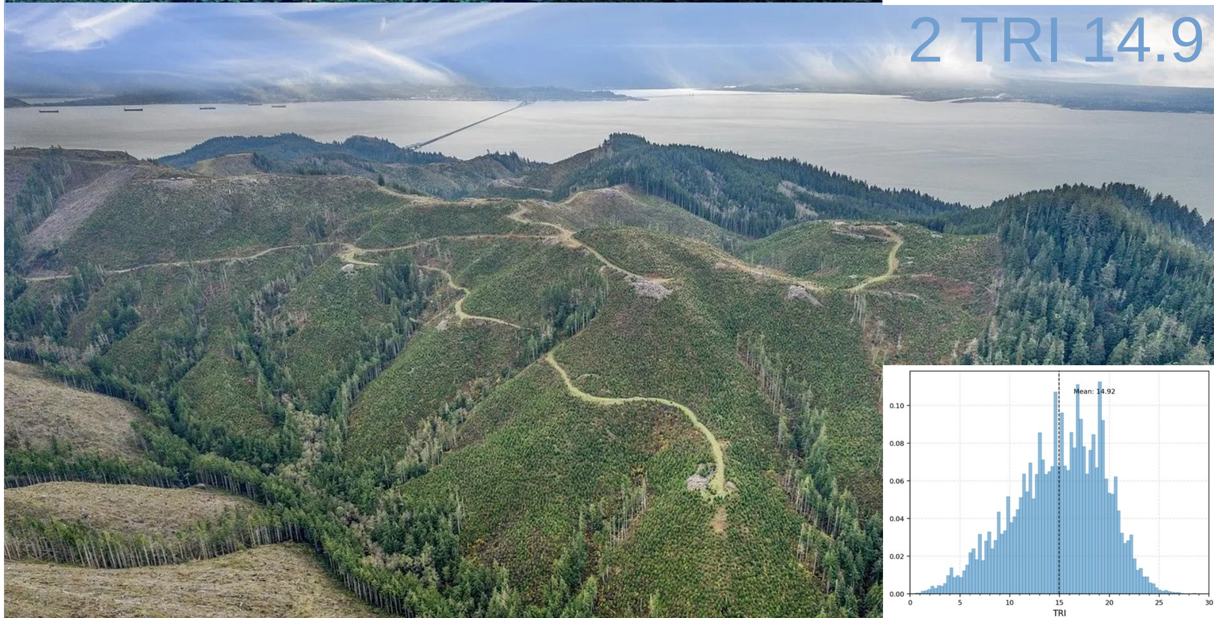
1 TTD/BPA Naselle Ridge



2 TTD/BPA Megler

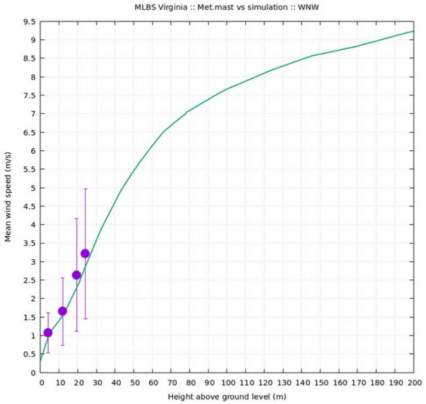




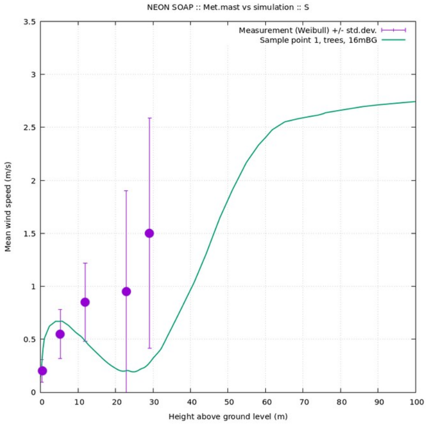


Validation sites

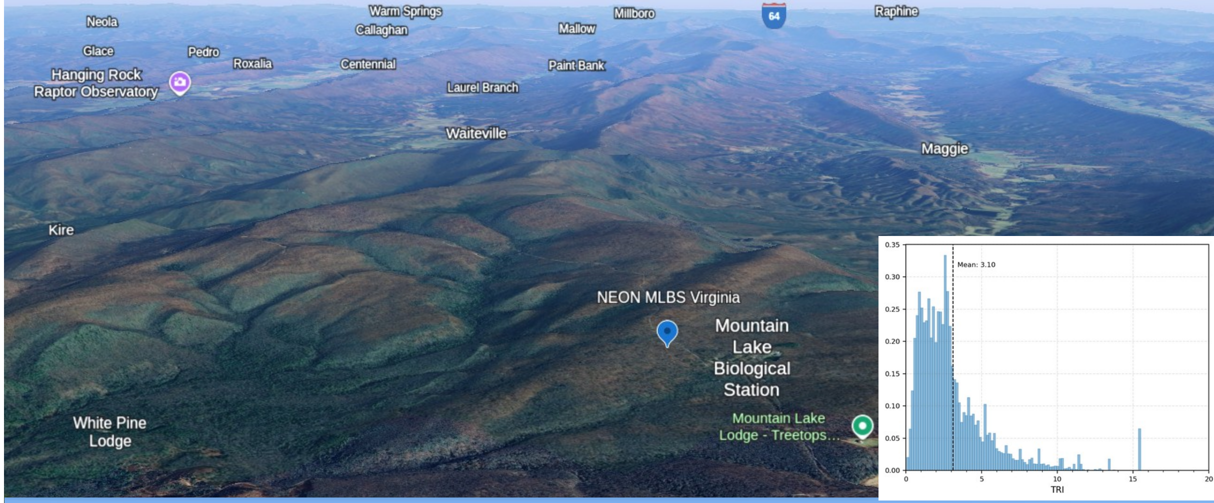
3 NEON MLBS



4 NEON SOAP



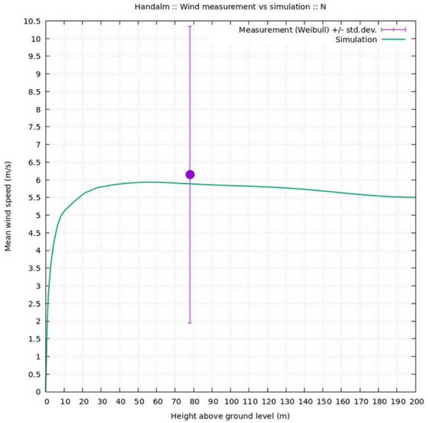
3 TRI 3.1



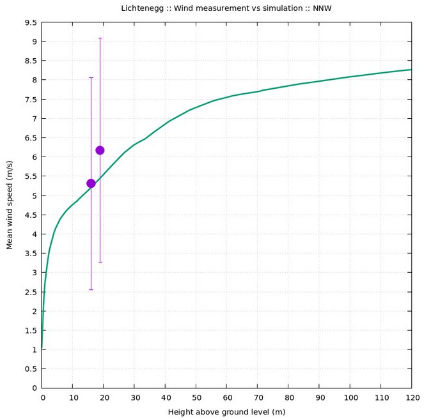
4 TRI 6.9

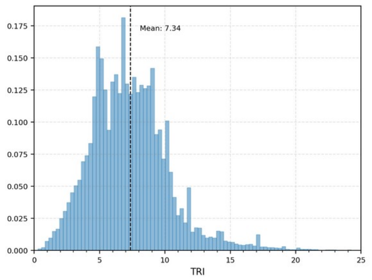
Validation sites

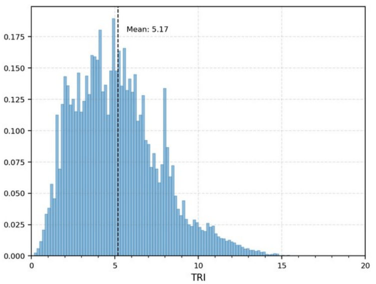
5 E-Stmk / Handalm



6 FHTW / EVN Lichtenegg







Validation sites

TRI ~ 7.3

Vertical wind speed profiles

1 TTD / BPA Naselle Ridge

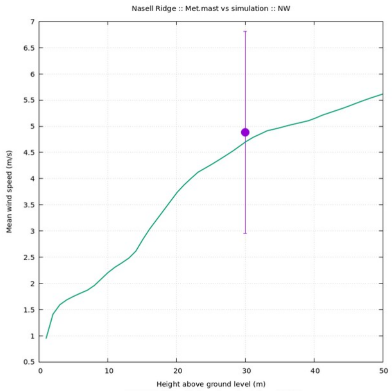
2 TTD / BPA Megler

3 NEON MLBS

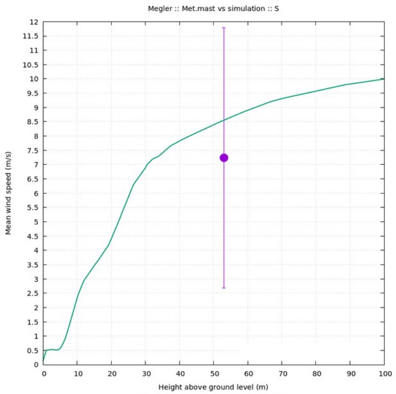
4 NEON SOAP

5 E-Stmk / Handalm

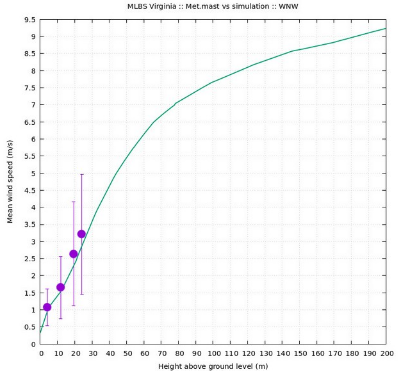
6 FHTW / EVN Lichtenegg



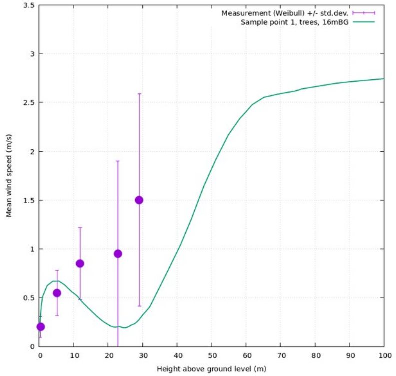
1



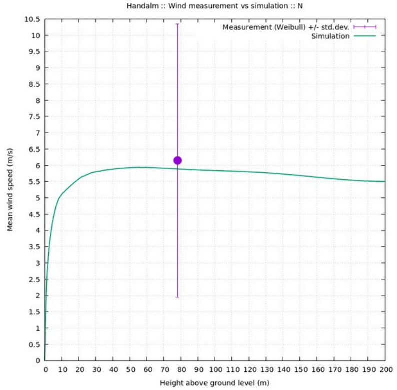
2



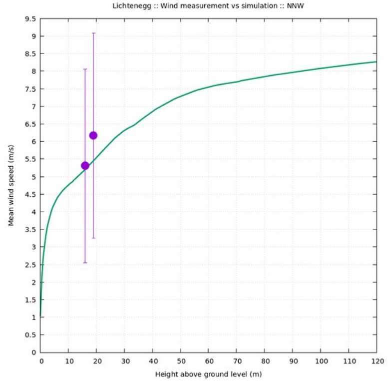
3



4



5



6

Simulation method accuracy

for z=[0.3; 78]m a.g.l

Avergage wind speed prediction

Bias (m/s)
$\mu = -0.39$

Standard deviation (m/s)
$\sigma = 0.73$

Average power density prediction for all sectors

Bias (W/m²)
$\mu = -17$

Standard deviation (W/m²)
$\sigma = 36$

Simulation method accuracy

By example

Calculation of max. AEP uncertainty

Year to year (Y2Y) AEP σ +/- (%)

Target name	Exp (%)	Sim (%)
Handalm	12.0	5.6
Lichtenegg	8.4	21.3
Megler	17.6	18.4
Naselle Ridge	12.7	11.7
Average	12.7	14.3

The average simulation method σ is similar to the Y2Y AEP fluctuation at the validated targets suitable for wind power generation.

Outlook

Listen to you...
and answer your questions

Increase the number and diversity of validation sites around the globe

Optimise run time & computational cost

Front end and user interface development

Tailor-made post processing and data analysis for wind power experts

Contact

Rheologic GmbH
Liniengasse 40/12
1060 Wien

andras.horvath@rheologic.at
https://rheologic.at
+43 699 81903236

Die FFG ist die zentrale nationale Förderorganisation und stärkt Österreichs Innovationskraft.
Dieses Projekt wird aus Mitteln der FFG gefördert. www.ffg.at

Google ARCO ERA5:

Carver, Robert W, and Merose, Alex. (2023): ARCO-ERA5: An Analysis-Ready Cloud-Optimized Reanalysis Dataset. 22nd Conf. on AI for Env. Science, Denver, CO, Amer. Meteo. Soc, 4A.1, https://ams.confex.com/ams/103ANNUAL/meetingapp.cgi/Paper/415842

Hersbach, H., Bell, B., Berrisford, P., Hirahara, S., Horányi, A., Muñoz Sabater, J., Nicolas, J., Peubey, C., Radu, R., Schepers, D., Simmons, A., Soci, C., Abdalla, S., Abellan, X., Balsamo, G., Bechtold, P., Biavati, G., Bidlot, J., Bonavita, M., De Chiara, G., Dahlgren, P., Dee, D., Diamantakis, M., Dragani, R., Flemming, J., Forbes, R., Fuentes, M., Geer, A., Haimberger, L., Healy, S., Hogan, R.J., Hólm, E., Janisková, M., Keeley, S., Laloyaux, P., Lopez, P., Lupu, C., Radnoti, G., de Rosnay, P., Rozum, I., Vamborg, F., Villaume, S., Thépaut, J-N. (2017): Complete ERA5: Fifth generation of ECMWF atmospheric reanalyses of the global climate. Copernicus Climate Change Service (C3S) Data Store (CDS). (Accessed on 03-03-2025)

Google satellite data imagery attribution